One Pillar Rising, Two Unbuilt: India's 2026 HPV Vaccination Launch, the Screening and Treatment Deficit, and the Two-Generation Gap in Cervical Cancer Elimination

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Received: 19 February 2026; Revised: 01 May 2026; Accepted: 06 May 2026; Published: 22 June 2026

Abstract

Background: India carries roughly one fifth of the world's cervical cancer cases and nearly one quarter of its deaths. On 28 February 2026 India launched its first nationwide human papillomavirus (HPV) vaccination programme, offering a free single dose of quadrivalent vaccine to approximately 1.15 crore girls aged 14 years. This addresses the first of the three pillars of the World Health Organization's 90–70–90 elimination strategy. The condition of the second and third pillars — screening and treatment — and the temporal relationship between vaccination and the mortality burden of the coming decades, have received far less attention.

Methods: We conducted a structured policy analysis synthesising published cancer burden estimates from GLOBOCAN 2022 and associated projections to 2050; national cervical cancer screening coverage from the fifth round of the National Family Health Survey (NFHS-5, 2019–21) and peer-reviewed secondary analyses of those data; a 2024 state-wide community-based survey from Tamil Nadu documenting the full screening-to-diagnosis care cascade; and official announcements and reporting on the 2026 HPV vaccination campaign. India's current position was mapped against each of the three 90–70–90 targets, and the age trajectory of the vaccinated cohort was compared with the projected burden.

Results: India recorded an estimated 127,526 new cases and 79,906 deaths in 2022, projected to rise to 229,056 cases (+80%) and 153,862 deaths (+92%) by 2050; the age-standardised mortality rate of 11.2 per 100,000 women is well above the global 7.1. Vaccination coverage advanced rapidly, exceeding 80 lakh doses within roughly seven months of launch. Against this, only 1.9% of women aged 30–49 had ever been screened (NFHS-5), ranging from 0.2% in Gujarat, Assam and West Bengal to 9.8% in Tamil Nadu. In the best-performing state, of 423 women ever screened, 108 were screen-positive but only 62 (57%) were referred onward; referral, not patient adherence, was the principal bottleneck, since 94% of those referred attended. The 2026 vaccinated cohort will not reach screening age until 2042 and peak incidence age until the mid-2050s.

Conclusion: Vaccination cannot influence the cervical cancer burden of the next two decades, which will arise almost entirely among women already born and unvaccinated. Only screening and treatment can. We propose a sequenced strategy that treats onward referral of every screen-positive woman as an auditable programmatic act, mandates private-sector screening reporting, and phases HPV-DNA testing into high-burden districts.

Keywords: Cervical Cancer, Hpv Vaccination, Cancer Screening, Care Cascade, Health Policy, India.

1. INTRODUCTION

1.1 A preventable cancer that India has not prevented

Cervical cancer occupies a singular position in oncology: it is the only major malignancy for which a vaccine against the causative agent, a cheap screening test, and a curative treatment for the precancerous stage all exist simultaneously. Where these three have been deployed together and sustained, incidence has fallen steeply, and elimination as a public health problem has become a realistic national objective. Where they

have not, the disease continues to kill women in their most productive years, typically after a decade or more of detectable precancerous change during which intervention would have been simple and inexpensive.

India sits at the unfavourable end of this distribution. Globally, an estimated 662,044 cases and 348,709 deaths from cervical cancer occurred in 2022, making it the fourth most common cause of cancer morbidity and mortality among women worldwide [1]. India accounted for approximately 19% of the world's cases and 23% of its deaths [1], with 127,526 new cases and 79,906 deaths [2,3]. The age-standardised mortality rate for Indian women, at roughly 11.2 per 100,000, substantially exceeds the global figure of about 7.1 [3]. Cervical cancer is the second most common cancer among Indian women and contributes roughly 18% of all female cancers [4].

The trajectory is adverse rather than merely high. Projections based on GLOBOCAN 2022 indicate that, absent accelerated intervention, new cases in India will rise from 127,526 in 2022 to 229,056 in 2050, an increase of approximately 80%, while deaths rise from 79,906 to 153,862, an increase of approximately 92% [2]. That mortality is projected to rise faster than incidence reflects demographic ageing and the persistence of late-stage presentation: studies in India consistently find that 60–70% of cases are diagnosed at an advanced stage [2].

1.2 The elimination framework and the 2026 inflection point

In November 2020 the World Health Organization launched the Global Strategy to Accelerate the Elimination of Cervical Cancer, defining elimination as an incidence below four cases per 100,000 women-years and setting three interim targets for 2030, universally referred to as 90–70–90: that 90% of girls be fully vaccinated against HPV by age 15; that 70% of women be screened with a high-performance test at ages 35 and again at 45; and that 90% of women identified with precancer or invasive cancer receive treatment [1,5].

On 28 February 2026, India took a decisive step on the first of these. The Prime Minister launched a nationwide HPV vaccination programme at Ajmer, Rajasthan, offering a free, voluntary single dose of quadrivalent vaccine to approximately 1.15 crore girls aged 14 years, delivered through government health facilities in an intensified 90-day campaign and thereafter through routine immunisation sessions, with records maintained on the U-WIN digital platform [6,7]. HPV vaccination thereby entered India's Universal Immunisation Programme for the first time, placing the country among more than 160 nations with the vaccine in their national schedules [7]. Early uptake has been substantial: more than 52 lakh doses by July 2026 and more than 80 lakh by September 2026 [8].

This is, unambiguously, a public health achievement of global consequence. Because India carries such a large share of the world's burden, a sustained national HPV programme moves the global elimination timeline in a way that no other single country's programme can. Nothing in this paper should be read as diminishing it.

1.3 The question this paper asks

The question is what the vaccination launch does, and does not, do for the women who will develop cervical cancer over the next two decades. Vaccination prevents infection; it does not treat established infection, clear existing precancer, or alter the natural history of disease in women already exposed. Its population effect is therefore realised only when the vaccinated cohorts themselves reach the ages at which cervical cancer occurs. For the cohort vaccinated in February 2026 — girls aged 14 — that means screening age is reached in 2042 and peak incidence age in the mid-2050s.

Every one of the 127,526 cases estimated for 2022, and very nearly all of those projected for 2050, will arise among women who were already born and unvaccinated when the programme launched. For that population, which is the population that will supply essentially the entire Indian cervical cancer mortality burden until well past 2050, the only available levers are the second and third pillars: finding precancer through screening, and treating it. This paper therefore examines the state of those two pillars, quantifies the gap between them and the 2030 targets, identifies where in the care pathway women are actually lost, and proposes a sequenced strategy matched to the timeline the biology imposes.

2. METHODS

2.1 Design

This is a structured policy analysis of published, publicly available data. No primary data were collected and no individual-level records were accessed; institutional ethics committee approval, informed consent and trial registration were therefore not applicable.

2.2 Data sources

Four source categories were used. Burden estimates were taken from GLOBOCAN 2022 and published analyses of it, including projections to 2050 [1–4]. National screening coverage was taken from NFHS-5 (2019–21) as reported in peer-reviewed secondary analyses of the survey factsheets and microdata [9–12]. Care-cascade data were taken from a 2024 state-wide community-based survey conducted in Tamil Nadu using the WHO STEPwise approach to NCD risk factor surveillance, which embedded a cervical cancer screening module administered to 4,184 women aged 30–69 years across all 38 districts [13]. Programme information on the 2026 vaccination campaign was taken from official announcements and contemporaneous reporting [6–8,14].

2.3 Analytical approach

India's position against each 90–70–90 target was estimated as follows. For the vaccination target, first-year coverage was computed as doses administered against the stated eligible cohort. For the screening target, the NFHS-5 lifetime coverage figure was used, with the caveat that the WHO target specifies two high-performance tests by age 45 while NFHS-5 records any lifetime screening by any method — meaning the true gap against the target as defined is wider than the figure suggests. For the treatment target, no national estimate exists; the conditional referral proportion from the Tamil Nadu cascade was used as the best available proxy for the onward-management step, and is presented as such rather than as a national treatment coverage figure.

The cohort timeline in Section 4.3 was constructed arithmetically from the vaccination age (14 years in 2026), the programmatic screening age in India (30 years under the National Programme for Prevention and Control of Non-Communicable Diseases) and the modal age of cervical cancer incidence (approximately 45 years). It is a demographic projection of a single birth cohort, not a transmission or natural-history model, and is intended to establish the ordering of events rather than to predict incidence. The strategy and recommendations in Section 5 are the authors' synthesis and are offered as proposals requiring evaluation, not as findings.

3. RESULTS

3.1 Burden and trajectory

Figure 1 sets India's contribution against the global total. India's share of deaths (23%) exceeds its share of cases (19%), and its age-standardised mortality rate is roughly 58% higher than the global figure — a differential that reflects late-stage presentation and incomplete treatment rather than any difference in the underlying disease [1,3].

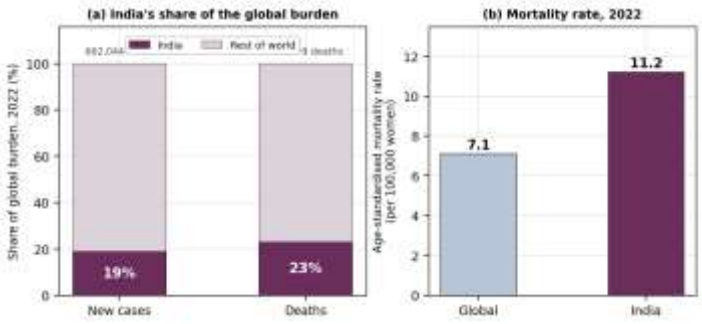

Figure 1. (a) India's share of global cervical cancer cases and deaths, 2022. (b) Age-standardised mortality rate, India compared with the global figure. Data sources: references [1,3].

Figure 2 and Table 1 present the projected trajectory. Both incidence and mortality are projected to increase substantially by 2050, with mortality rising faster than incidence [2]. The policy significance of this asymmetry is that it identifies the limiting factor. If mortality were rising purely in proportion to incidence, primary prevention would be the dominant lever. That mortality is rising faster indicates that detection and treatment failure is compounding the incidence trend — and detection and treatment failure is remediable within the current decade, whereas incidence reduction through vaccination is not.

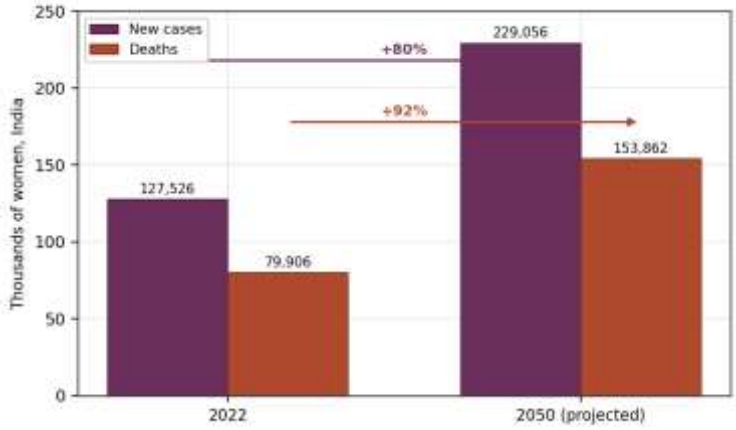

Figure 2. Projected cervical cancer cases and deaths in India, 2022 to 2050. Data source: reference [2].

Table 1. Cervical cancer burden, India and globally, 2022, with Indian projections to 2050.

Indicator	Global, 2022	India, 2022	India, 2050 (projected)
New cases	662,044	127,526	229,056 (+80%)
Deaths	348,709	79,906	153,862 (+92%)
Share of global cases	—	≈19%	—
Share of global deaths	—	≈23%	—
Age-standardised incidence rate (per 100,000)	14.1	≈18	—
Age-standardised mortality rate (per 100,000)	7.1	≈11.2	—
Rank among cancers in women	4th	2nd	—

Projections are those published from GLOBOCAN 2022 data under an assumption of unchanged age-specific rates with demographic change. Sources: references [1–4].

3.2 Position against the three elimination targets

Figure 3 and Table 2 place India against each 90–70–90 target. The contrast between the pillars is stark. Within roughly seven months of launch the vaccination programme had reached in the order of 70% of a single annual cohort, a pace that compares favourably with the early phase of most national HPV programmes and that state-level reporting corroborates — Haryana's coverage doubled to 12% within ten days of launch, and Sikkim's earlier school-based pilot achieved above 95% [8,14,15].

Screening presents the opposite picture. NFHS-5 found that 1.9% of women aged 30–49 had ever been screened for cervical cancer [9,10]. The target is 70% screened twice with a high-performance test by age 45. Even taking the reported figure at face value, India stands at approximately one thirty-seventh of the target; taking the target as specified — two high-performance tests rather than any lifetime screening of any kind — the true shortfall is larger still, because VIA, the method used in the national programme since 2016, is not a high-performance test in the sense the WHO strategy intends [2,16].

For treatment, no national coverage estimate exists at all, which is itself a finding. The best available proxy, from the Tamil Nadu cascade analysed in Section 3.4, is that 57% of screen-positive women were referred onward for diagnostic evaluation [13]. Against a target of 90% treated, and noting that referral is only the first of several subsequent steps, the gap is substantial.

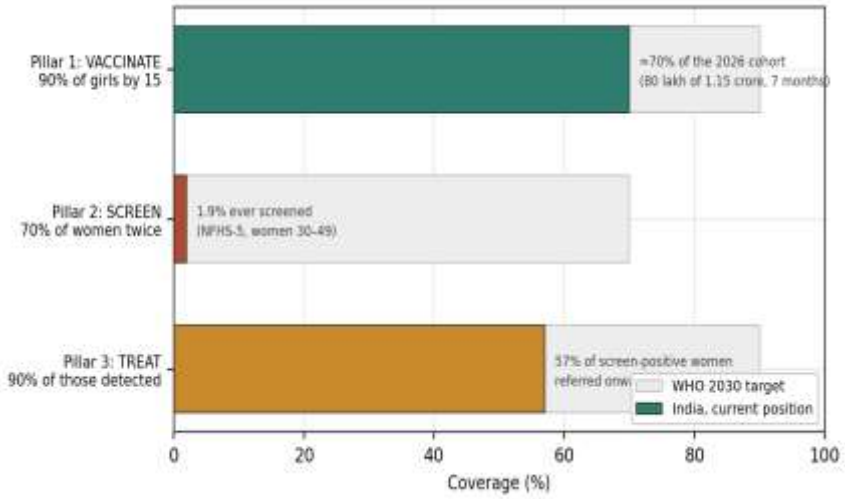

Figure 3. India's position against the three WHO 90–70–90 targets. Note that the screening figure records any lifetime screening by any method, a less demanding criterion than the target, and that the treatment figure is a referral proxy from a single state rather than a national estimate. Data sources: references [8,9,13].

Table 2. India's position against each of the WHO 90–70–90 targets for 2030.

Pillar	WHO target by 2030	India's current position	Principal constraint
Vaccinate	90% of girls fully vaccinated by age 15	≈70% of the first annual cohort within seven months of launch	Sustaining annual cohorts; no catch-up for older unvaccinated girls
Screen	70% of women screened with a high-performance test at 35 and 45	1.9% of women aged 30–49 ever screened by any method (NFHS-5)	Near-absent population screening; VIA is not a high-performance test
Treat	90% of women with precancer or cancer treated	No national estimate; 57% of screen-positive women referred onward (Tamil Nadu)	Referral failure at the primary-care to secondary-care interface

3.3 Screening coverage and its distribution

National screening coverage is not merely low; it is unevenly low in a pattern that tracks health system capacity rather than disease burden (Figure 4, Table 3). Coverage ranged from 0.2% in Gujarat, Assam and West Bengal to 9.8% in Tamil Nadu, followed by Puducherry at 7.4% and Mizoram at 6.9% [10]. Multivariable analysis of the NFHS-5 microdata found markedly higher odds of screening among women resident in southern India (OR 6.66, 95% CI 5.93–7.49) and in the western region (OR 1.62, 95% CI 1.40–1.87), among women aged 40–49 (OR 1.35, 95% CI 1.28–1.43) and among those with higher educational attainment (OR 1.46, 95% CI 1.31–1.62) [12]. Wealth gradients operate in the same direction, with poorer and middle wealth quintiles significantly less likely to be screened [9].

International comparison sharpens the point. Approximately one in three women worldwide had been screened in their lifetime as of 2019, and a pooled analysis of nationally representative surveys from 55 low- and middle-income countries reported a country-level median lifetime coverage of 43.6%, with Bhutan at 51% and Sri Lanka at 21% [13,17,18]. India's 1.9% is therefore not a typical low- and middle-income figure; it is an outlier, and Sri Lanka's coverage is more than ten times India's despite broadly comparable per-capita resources.

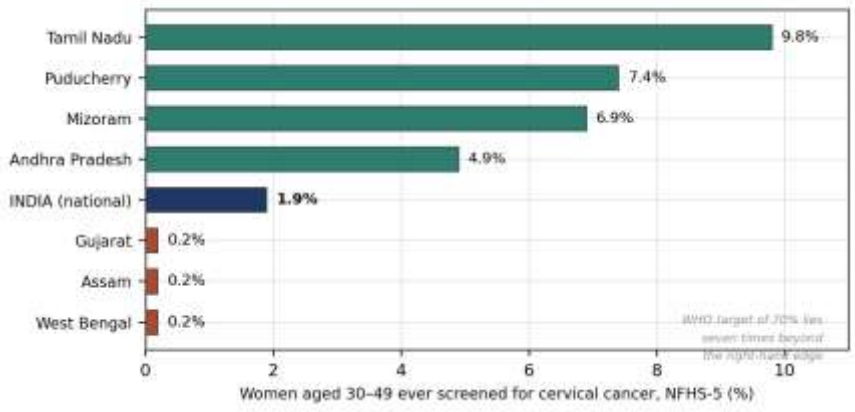

Figure 4. Lifetime cervical cancer screening coverage among women aged 30–49 years by state, NFHS-5 (2019–21), showing the highest- and lowest-reporting states with the national figure. Data source: reference [10].

Table 3. Lifetime cervical cancer screening coverage, women aged 30–49 years, NFHS-5.

State / Union Territory	Coverage (%)	Position	Comparator
Tamil Nadu	9.8	Highest in India	Global lifetime coverage ≈33%
Puducherry	7.4	Second	LMIC median 43.6%
Mizoram	6.9	Third	Bhutan 51%
Andhra Pradesh	4.9	Fourth	Sri Lanka 21%
INDIA (national)	**1.9**	**—**	**South-East Asia region ≈8%**
Gujarat	0.2	Lowest tier	—
Assam	0.2	Lowest tier	—
West Bengal	0.2	Lowest tier	—

Sources: references [10,13,17,18]. Coverage records any lifetime screening by any method, self-reported.

3.4 Where women are lost: the care cascade

Low coverage is the first failure; what happens to women who are screened is the second, and it is less visible. The Tamil Nadu STEPS survey of 4,184 women aged 30–69 years traced the full pathway (Figure 5, Table 4) [13]. Of those surveyed, 423 (10%) had ever been screened. Among the 423, 108 (26%) were screen-positive, 62 (15% of screened) were referred for colposcopy, 58 (14%) attended the colposcopy centre, 56 (13%) underwent colposcopy, 42 (10%) had an abnormal finding, 38 (9%) underwent biopsy, and one (0.2%) received a diagnosis of cervical cancer.

Read as conditional proportions, the cascade identifies the bottleneck unambiguously. Of 108 screen-positive women, only 62 (57%) were referred onward — meaning 43% of women whose screening test was abnormal were never referred at all. Of those who were referred, 94% attended, and 97% of attenders underwent colposcopy [13]. This ordering matters enormously for policy. The dominant loss is not patient non-adherence, not distance, not cost, and not fear; those factors would manifest as attrition between referral and attendance, and that step is 94% complete. The dominant loss occurs inside the health facility, at the moment a provider should have made a referral and did not.

This finding is consistent with the wider Indian literature. A systematic review of community-based VIA screening programmes in India found loss to follow-up among screen-positive women referred for colposcopy ranging from 10% to 71%, with all but one study exceeding 40% [13]. An earlier programme-data study from Tiruchirappalli district found 42% of VIA-positive women non-compliant with colposcopy, and a study from south India reported 57% [13].

Two further features of the Tamil Nadu data bear on programme design. First, 59% of women who were screened were screened in private facilities, rising to 72% among urban women [13]. Because the national programme tracks screening in government facilities, routine programme data systematically understate true coverage and, more seriously, cannot follow screen-positive women detected privately into the public

diagnostic system. Second, among the 3,761 women never screened, 79% gave as their reason that they felt normal [13] — which is to say that the single largest barrier to screening in the best-performing state in India is the absence of a public understanding that cervical screening is for women without symptoms.

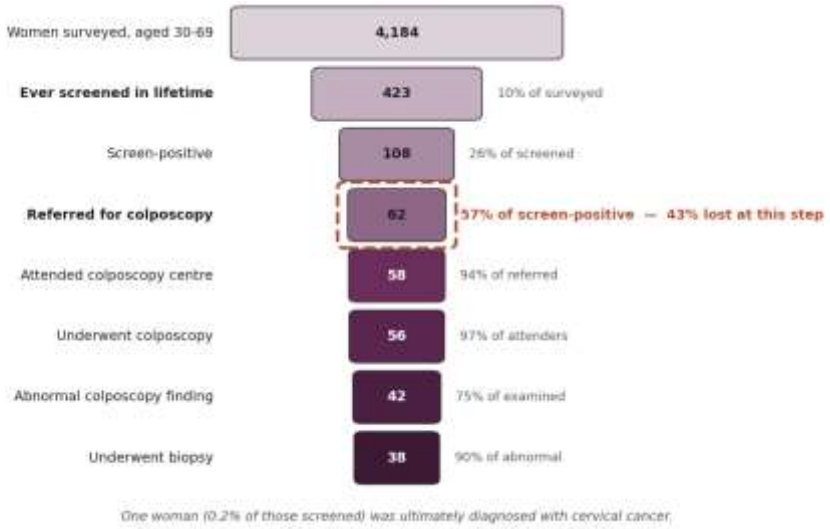

Figure 5. Cervical cancer screening and diagnostic care cascade among women aged 30–69 years, Tamil Nadu, 2024. Boxes show absolute numbers; right-hand labels show conditional step-to-step proportions. Data source: reference [13].

Table 4. Cervical cancer care cascade, Tamil Nadu 2024, with fixed and conditional denominators.

Cascade step	n	% of all screened (n = 423)	% of preceding step	Loss at step
Women surveyed, aged 30–69	4,184	—	—	—
Ever screened in lifetime	423	100	10% of surveyed	90%
Screen-positive	108	26	26%	—
Referred for colposcopy	**62**	**15**	**57%**	**43%**
Attended colposcopy centre	58	14	94%	6%
Underwent colposcopy	56	13	97%	3%
Abnormal colposcopy finding	42	10	75%	—
Underwent biopsy	38	9	90%	10%
Diagnosed with cervical cancer	1	0.2	—	—

Screen-positivity is not a 'loss' step. Loss at the abnormal-finding step is not computable because a normal colposcopy is an appropriate endpoint. Source: reference [13].

3.5 The vaccination programme

Table 5 summarises the design of the 2026 campaign. Three features are worth noting for their bearing on the argument. The single-dose schedule, consistent with the WHO 2022 position paper permitting one or two doses for girls aged 9–14 years, materially simplifies delivery and India has contributed directly to the evidence base supporting it, including an ICMR study initiated in November 2024 among 500 girls aged 9–14 [14,19]. The use of U-WIN for record-keeping creates, in principle, an individual-level vaccination register that could later be linked to screening records — an asset whose value is discussed in Section 5.3. And the programme targets a single age cohort with no catch-up provision for older unvaccinated girls and young women, which bounds its reach in a way examined next.

Table 5. Design characteristics of India's national HPV vaccination programme, 2026.

Characteristic	Specification	Implication
Launch	28 February 2026, Ajmer, Rajasthan	HPV enters the Universal Immunisation Programme
Target cohort	Girls aged 14 years; approximately 1.15 crore annually	Single-cohort strategy; no catch-up for older girls
Vaccine	Quadrivalent (HPV 6, 11, 16, 18)	Covers the types causing about 70% of cervical cancers
Schedule	Single dose	Consistent with WHO 2022 position paper for ages 9–14
Delivery	PHCs, CHCs and district hospitals; 90-day intensified campaign then routine sessions	Facility-based rather than school-based at national level
Cost and consent	Free of cost; voluntary	Uptake depends on demand generation
Records	U-WIN digital platform	Individual-level register linkable to future screening records
Early uptake	>52 lakh doses by July 2026; >80 lakh by September 2026	Approximately 70% of the first cohort within seven months

PHC = Primary Health Centre; CHC = Community Health Centre. Sources: references [6–8,14,19].

4. THE TWO-GENERATION GAP

4.1 What vaccination can and cannot reach

HPV vaccination is prophylactic. It prevents acquisition of the vaccine-covered types; it does not clear established infection, does not regress existing cervical intraepithelial neoplasia, and confers no benefit on women already exposed. Its population-level effect on cervical cancer incidence therefore appears only when vaccinated cohorts themselves enter the age range in which cervical cancer occurs.

Figure 6 traces that arithmetic for the cohort vaccinated in February 2026. Girls aged 14 in 2026 reach the Indian programmatic screening age of 30 years in 2042. They reach approximately 45 years — near the modal age of cervical cancer incidence — in the mid-2050s. The earliest point at which this cohort could contribute meaningfully to a measurable decline in national cervical cancer incidence is therefore the 2050s, and a full cohort effect requires successive annual cohorts to age through the same interval, extending well into the second half of the century.

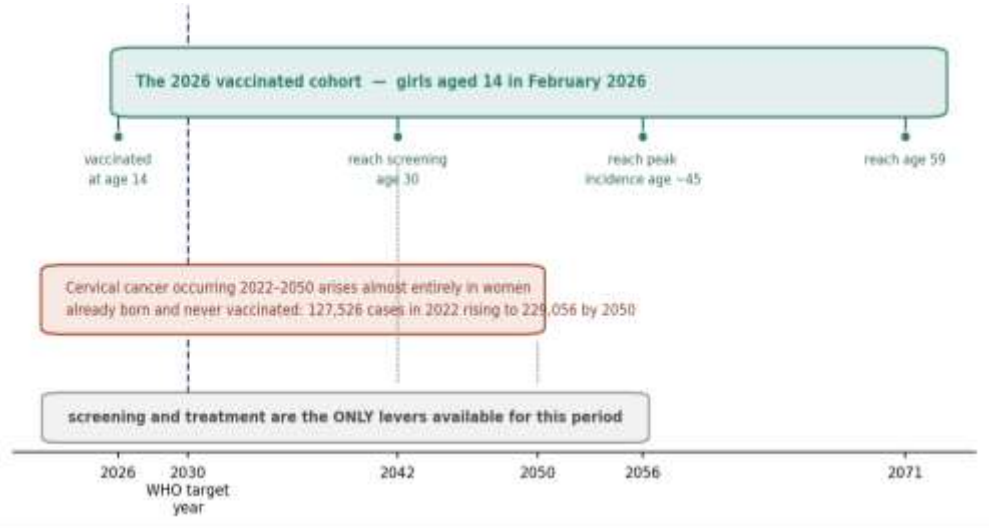

Figure 6. Timeline of the 2026 vaccinated cohort against the projected burden. The cohort reaches screening age in 2042 and peak incidence age in the mid-2050s, while the cases and deaths projected for 2022–2050 arise among women already born and unvaccinated. Data sources: references [2,6].

4.2 The population that vaccination cannot help

The corollary is straightforward and, we would argue, insufficiently stated in Indian policy discussion. The 127,526 cases estimated for 2022 and the 229,056 projected for 2050 arise overwhelmingly among women born before 2012 — that is, among women who were already too old to be reached by the 2026 programme when it launched. Over the twenty-four years between the launch and the 2050 projection horizon, cumulative cases and deaths in this unvaccinated population will number in the millions.

For that population there are exactly two effective interventions: detect precancer through screening and treat it, or detect cancer early and treat it. Neither is exotic, expensive, or technically demanding. Both are, on the evidence in Section 3, close to absent at national scale. The uncomfortable implication is that India's most visible and most celebrated cervical cancer intervention is the one that cannot affect the disease burden of the current generation, while the two interventions that could affect it have received no comparable programmatic push.

We emphasise that this is not an argument against vaccination, which is both the correct long-run strategy and the only means of eventually reaching the elimination threshold. It is an argument about sequencing and about the risk that a highly visible success on one pillar is read, politically and administratively, as progress on the problem as a whole.

4.3 Why the 2030 target year is effectively a screening and treatment target

A useful way to state the conclusion is this. Of the three 90–70–90 targets, only the first is on any plausible trajectory in India, and achieving it will have no effect whatsoever on cervical cancer incidence or mortality by 2030, because no vaccinated girl will have reached cancer age. The second and third targets are the only ones whose achievement would change outcomes within the target period — and they are the two on which India is furthest behind. Whatever is achieved on vaccination by 2030, the mortality figure India records in 2030 will be determined entirely by how many precancerous lesions were found and treated in the intervening years.

5. A SEQUENCED STRATEGY

Figure 7 sets out a strategy organised by the timeline the biology imposes rather than by the three pillars in parallel. Table 6 maps the barrier evidenced at each pillar to a proposed response, and Table 7 gives specific recommendations.

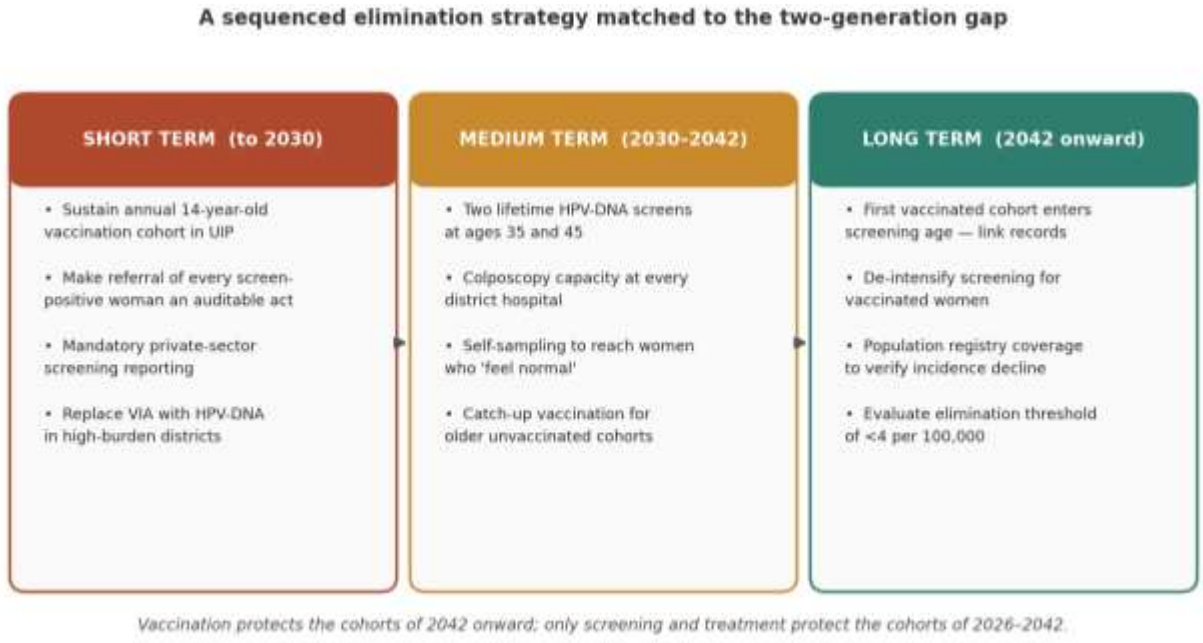

Figure 7. A sequenced cervical cancer elimination strategy for India, organised by the period over which each intervention can affect outcomes.

5.1 Short term: make referral auditable

The single highest-yield change available to India is also the cheapest. The Tamil Nadu cascade shows that 43% of screen-positive women were never referred onward, while 94% of those referred did attend [13]. The loss is a provider action not taken, inside a facility, in a system that does not currently record whether it was taken. We therefore propose that referral of a screen-positive woman be constituted as a discrete, individually recorded programmatic act with a unique identifier, so that the denominator of screen-positive women and the numerator of referrals issued are both visible at facility, block and district level. Nothing else in this paper is as inexpensive or as immediately actionable.

Two supporting measures follow. Standard referral scripts and brief point-of-screening counselling address the communication gap that the cascade study identifies [13]. And mandatory reporting of screening outcomes by private facilities addresses the finding that 59% of screening occurred in the private sector, invisible to programme data and disconnected from the public diagnostic pathway [13].

5.2 Medium term: change the test and reach the asymptomatic

VIA was adopted as the primary screening method under the national programme in 2016; cervical cancer death rates nevertheless continued to rise thereafter, from 6.06–6.78 per 100,000 in 2012–2016 to 6.82–6.91 in 2016–2019 [2]. VIA is operator-dependent, has limited sensitivity, requires the woman to attend a facility, and is not a high-performance test within the meaning of the WHO strategy. Phased introduction of HPV-DNA testing in high-burden districts, with self-sampling as a delivery option, addresses several constraints simultaneously: it removes operator dependence, permits a two-lifetime-test schedule consistent with the 70% target, and — through self-sampling — reaches women who would not otherwise present.

Reaching the asymptomatic is the other half of the problem. That 79% of never-screened women in Tamil Nadu cited feeling normal [13] indicates a failure of communication rather than of access, and it is a failure that a facility-based service model cannot correct, since women who feel well do not attend facilities. Self-sampling distributed through existing community platforms addresses the barrier where it exists.

Catch-up vaccination for older unvaccinated girls and young women also belongs in this period. The current single-cohort design leaves every girl older than 14 in February 2026 unprotected, and the marginal cost of extending to adjacent cohorts is low relative to the infrastructure already built.

5.3 Long term: use the register that is being created

When the 2026 cohort reaches screening age in 2042, India will face a question that few countries have yet had to answer at scale: how should screening be modified for vaccinated women? Vaccinated populations have lower precancer prevalence, which reduces the positive predictive value of screening and argues for later initiation and longer intervals. Answering this requires individual-level linkage between vaccination status and screening results. The U-WIN platform is creating exactly the necessary vaccination register now; the corresponding screening register does not yet exist. Building it, with a common identifier, is a decision that costs little today and is extremely expensive to retrofit in 2042.

Table 6. Evidenced barrier and proposed response by elimination pillar.

Pillar	Evidenced barrier	Evidence	Proposed response
Vaccinate	Single-cohort design leaves older girls unprotected; acceptability has been challenging in earlier limited roll-outs	Programme design [6,14]	Phased catch-up for adjacent cohorts; sustained demand generation
Screen	Coverage 1.9%; 79% of never-screened women report feeling normal; VIA not a high-performance test	NFHS-5 [9,10]; Tamil Nadu STEPS [13]	HPV-DNA with self-sampling in high-burden districts; asymptomatic-screening communication
Screen	59% of screening occurs in private facilities, invisible to programme data	Tamil Nadu STEPS [13]	Mandatory private-sector screening notification and quality accreditation

Treat	43% of screen-positive women never referred onward; 94% of those referred do attend	Tamil Nadu STEPS [13]; systematic review [13]	Referral as an auditable individual act; standard referral scripts; colposcopy capacity at every district hospital
Cross-cutting	60–70% of cases present at advanced stage	Published Indian series [2]	Symptom-awareness campaigns alongside asymptomatic screening

Table 7. Recommendations, indicative responsibility and horizon.

Recommendation	Indicative responsibility	Horizon	Target addressed
Record referral of every screen-positive woman as a discrete auditable act with unique identifier	NP-NCD, State NCD cells	Immediate	Treat (90%)
Mandate private-sector notification of cervical screening outcomes	MoHFW with State health departments	Short term	Screen (70%)
Publish district-level screening coverage and cascade completion annually	NP-NCD	Short term	Screen and Treat
Phase HPV-DNA testing with self-sampling into the highest-burden districts	MoHFW with ICMR	Medium term	Screen (70%)
Establish colposcopy capacity and a named gynaecologist at every district hospital	State health departments	Medium term	Treat (90%)
Extend HPV vaccination to catch-up cohorts beyond age 14	MoHFW, NTAGI	Medium term	Vaccinate (90%)
Build a screening register with a common identifier linkable to U-WIN	MoHFW	Short term, for 2042 use	All three
Expand population-based cancer registry coverage to verify incidence trends	ICMR-NCDIR	Medium term	Verification

ICMR = Indian Council of Medical Research; MoHFW = Ministry of Health and Family Welfare; NCDIR = National Centre for Disease Informatics and Research; NP-NCD = National Programme for Prevention and Control of Non-Communicable Diseases; NTAGI = National Technical Advisory Group on Immunisation. Recommendations are the authors' synthesis.

6. DISCUSSION

Three conclusions follow from this analysis. India's HPV vaccination launch is a genuine achievement with global significance, given the share of world burden the country carries. It cannot, by the arithmetic of cohort ageing, influence cervical cancer incidence or mortality before the 2050s. And the two interventions that could influence outcomes within the current decade stand at 1.9% coverage and at an unmeasured national treatment rate whose best available proxy is a 43% referral failure.

The most actionable finding is the cascade result, and it deserves emphasis because it inverts a common assumption. Indian discussion of cervical screening failure has focused predominantly on demand-side barriers: stigma, fear, women's reluctance to undergo a pelvic examination, distance, and cost. The Tamil Nadu data indicate that once a woman has been screened and found positive, the health system loses her not because she declines to proceed but because she is never asked to. A 94% attendance rate among referred women is, in fact, evidence of strong demand. The failure is supply-side, and supply-side failures are within the direct control of programme managers in a way that cultural barriers are not.

A second observation concerns measurement. There is no national estimate of cervical cancer treatment coverage in India. This is not a gap in the literature that a study could fill; it is a gap in the programme's own information architecture, since routine data track screening in government facilities but not onward referral, not private-sector screening, and not treatment completion. The third pillar of the elimination strategy is therefore not merely unmet but unmeasured, and a target that cannot be measured cannot be managed.

Third, the state-level pattern in Figure 4 warrants attention. The gradient favouring southern states is very steep — a sixfold adjusted odds ratio [12] — and it does not correspond to burden. Districts and states with the least screening are not those with the least disease. Any national scale-up that proceeds by extending existing capacity will widen this gradient rather than close it, because existing capacity sits where coverage is already highest. Targeting should be explicitly burden-weighted.

These findings have relevance beyond India. Several countries in South Asia and comparable settings are introducing or expanding HPV vaccination while screening coverage remains minimal. The sequencing argument made here applies generally: a national HPV programme should be understood as a commitment to the cohorts of the 2050s, and should be accompanied by, not substituted for, a screening and treatment programme serving the cohorts of the present.

Limitations

First, this is a synthesis of published estimates rather than a reanalysis of microdata; reported values are taken as documented in the cited sources.

Second, the cascade evidence derives from a single state. Tamil Nadu has the highest screening coverage in India and a mature programme that predates the national one, so its cascade is likely to represent a better-than-average performance. The national referral failure rate is plausibly higher than 43%, not lower, but this cannot be verified from available data and the figure should not be treated as a national estimate.

Third, cascade data in the source study were self-reported rather than abstracted from clinical records, raising the possibility of misclassification of individual steps and of recall error in the timing of screening [13]. Screen-positivity may also be inflated if some women did not distinguish screening from symptom-driven diagnostic evaluation.

Fourth, NFHS-5 screening coverage is self-reported lifetime screening by any method, which is neither the numerator nor the denominator the WHO target specifies. It is used here as the only nationally representative measure available, and the direction of any resulting bias is toward overstating India's position relative to the target.

Fifth, the cohort timeline is a demographic projection of a single birth cohort and does not model HPV transmission dynamics, herd effects among unvaccinated women, or changes in age-specific incidence. Herd protection could bring forward the population effect of vaccination somewhat; it does not alter the conclusion that the effect is realised decades after administration.

Sixth, the 2050 projections assume unchanged age-specific rates applied to projected demography. They are best read as a counterfactual describing what happens if screening and treatment do not improve, which is precisely the comparison this paper intends, but they are not forecasts.

7. CONCLUSION

India has built the first pillar of cervical cancer elimination with impressive speed. The second and third remain substantially unbuilt: fewer than two women in a hundred aged 30–49 have ever been screened, and in the state that screens most, two in five women whose screening test was abnormal were never referred for the diagnostic evaluation that would have followed.

Because HPV vaccination protects only the vaccinated, and because the cohort vaccinated in 2026 will not reach cancer-prone age until the 2050s, the cervical cancer deaths India records between now and mid-century — rising, on current projections, from around 80,000 a year to over 150,000 — will occur almost entirely among women whom the vaccine cannot reach. For them, screening and treatment are not complementary strategies; they are the only strategies.

The most immediately actionable conclusion is narrow and cheap. Making the onward referral of every screen-positive woman a recorded, auditable act would address the largest single point of loss in the

pathway, requires no new technology, and could be implemented within the current programme structure. India has demonstrated, with the vaccination launch, that it can execute a complex national health intervention at speed. The same capability applied to the second and third pillars would change outcomes for women who are alive now.

Declarations

Ethical approval: Not applicable.

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Conflicts of interes: The authors declare that there are no conflicts of interest regarding the publication of this paper.

Data availability: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author contributions:

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Makbul Hussain Choudhury	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

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